Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Engineering Thermodynamics and Heat Transfer
Course code	42173
Scientific sector	ING-IND/11
Degree	Bachelor in Industrial and Mechanical Engineering
Semester	2
Year	2
Academic Year	2021-2022
Credits	10
Modular	no

Total lecturing hours	64
Total lab hours	
Total exercise hours	30
Attendance	Not compulsory
Prerequisites	
Course page	https://www.unibz.it/de/faculties/sciencetechnology/bachelor-industrial-mechanical-engineering/course-offering/

Specific educational objectives	The course is a core teaching in the context of the bachelor in Industrial and Mechanical Engineering and in particular within the area of Energy Engineering. The aim of the course is to provide the students with a suitable knowledge of the general scientific contents, of the methods and of some specific professional skills. The course deals with the fundamentals of engineering thermodynamics, which are needed to understand the conventional and innovative energy conversion systems. The study of prime movers based on direct cycles (steam and gas cycles) and inverse cycle systems is presented. Fundamentals of heat transfer and heat exchanger design and operation and thermodynamics of moist air complete the course program. The students will learn theoretical concepts as well as acquire the ability to apply these concepts to some reference system calculations.

Lecturer	Andrea Gasparella, K0.08, andrea.gasparella@unibz.it 0471 017200, https://www.unibz.it/en/faculties/sciencetechnology/academic-staff/person/30619-andrea-gasparella Marco Baratieri, K0.03, marco.baratieri@unibz.it 0471 017201, https://www.unibz.it/en/faculties/sciencetechnology/academic-

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	staff/person/27442-marco-baratieri
Scientific sector of the lecturer	ING-IND/11
Teaching language	English
Office hours	Monday to Wednesday by appointment
Teaching assistant (if any)	
Office hours	
List of topics covered	FUNDAMENTALS OF THERMODYNAMICS Units of measure and fundamentals of Thermometry. First Law of Thermodynamics for open and closed systems. Enthalpy. Applications. Ideal gas. . Second Law of Thermodynamics, statements. Irreversible processes. Direct and inverse cycles. Carnot Cycle. Thermodynamic temperature scale. Clausius theorem and inequality. Entropy and irreversible processes. Thermodynamic state, state functions and thermodynamic charts. P-v-T surface for a pure substance. ENERGY CONVERSION Conventional energy sources. Steam cycle. Conventional steam plants, components. Internal combustion engines. Alternative engines: Otto and Diesel cycles. Gas-turbine plants: Brayton-Joule cycle. Combined cycle plants. REFRIGERATION AND COGENERATION Inverse cycle systems. Refrigeration systems and heat pumps. Vapor compression and adsorption systems. Combine heat and power production (CHP) systems. Trigeneration systems. HEAT TRANSFER Heat transfer mechanisms. Thermal heat conduction in monodimensional systems in steady state. Thermal heat convection and dimensional analysis. Global heat transfer and heat exchangers. Thermal radiation. THERMODYNAMIC OF MOIST AIR Gas and vapour mixtures. Thermodynamic properties of moist air. Processes of moist air. Winter and summer air conditioning cycles.
Teaching format	The course consists of classroom lectures. There are also exercise classes that will give practical examples of the application of the theoretical topics. Course topics will be presented through presentations. Integrative teaching material will be available for the students through the reserve collection.

Learning outcomes (ILOs)	The learning outcomes need to refer to the Dublin Descriptors: Knowledge and understanding 1. Knowledge and understanding of the fundamentals topics dealing with technical systems' energy balance, heat transfer mechanisms and thermodynamic processes. Applying knowledge and understanding 2. Applying knowledge and understanding to the solution of energy balance analysis and to the quantification of energy fluxes within and among physical systems Making judgements 3. Making judgments through the acquisition of the basics of the thermodynamic analysis of complex systems and the analysis approach based on simplification and de-structuration. Communication skills 4. Communication skills dealing with the correct use of highly specific terms and definitions, including the correct use and conversion of the units of measurement Ability to learn 5. Lifelong learning skills through the comparison of different sources, and engineering methods and the acquisition of a critical sense

Assessment

Formative assessment

Form	Length /duration	ILOs assessed
In class exercises and discussion	30 hours (average duration 30 minutes/exercise)	1, 2, 3, 4, 5

Summative assessment

The exam consists of two written parts.

	The first deals with the solution of a well-structured numerical exercise related to the calculation of energy balance and exchanges of the technical systems considered in the course. This way we can assess the ability of the student of applying the knowledge and understanding of the analysis and solution techniques, and of making judgment and to correctly use the units of measurement. The second one consists of some open questions dealing with theoretical aspects of each main topic of the course (engineering thermodynamics, heat transfer, thermodynamics of moist air). This way the knowledge and understanding of the fundamental topics, the written communication skills are assessed

Form	%	Length /duration	ILOs assessed
Written exam – numerical exercise	33%	1 exercises (1 hour)	1, 2, 3
Written exam – theory	67%	3 open-ended questions (1.5 hours)	1, 2, 3, 4, 5

Assessment language	English
Evaluation criteria and criteria for awarding marks	To the admission to the second part the first one has to be successfully passed. The first part (numerical exercise) consists of six numerical questions. The answer is correct when the number provided is within a given tolerance with respect to the reference value. Each student works on the same problem but with personal starting data. The evaluation is based on the accuracy of the numerical result of each question. The starting mark is assigned considering 3 points per each correct answer (starting from 12). The score of this part contributes for 1/3 to the final mark. In the second part, each question – out of the proposed 3 – concerns a different section of the program (applied thermodynamics, heat transfer, thermodynamics of moist air). It equally contributes to the mark, with the exception of one of the 3, which is 4/3 of the others- and requires some steps to prove a proposition. The evaluation is based on the completeness of the answer in terms of 1) definition of the subject 2) analytical description 3) graphical and mathematical representations 4) proof (if

	required) The score of this second part contributes for 2/3 of the final mark.

Required readings	Teacher's handouts and booklets (available in the reserve collection)
Supplementary readings	• G.F.C. Rogers, Yon Mayhew. Engineering Thermodynamics: Work and Heat Transfer (4th Edition) Pearson Education (1996) • F. Incropera, D. DeWitt, Fundamentals of Heat and Mass Transfer (5^{th} Edition) Wiley (2002)